To Study Properties of Concrete by Replacing Fresh Water with Treated Waste Water

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Abstract: *In construction industry concrete being most widely used construction material. The mixing of water which is fit for drinking purpose is fit for concreting, but about 97 percent of water is held in the oceans, while only 3 percent is fresh water. Of the freshwater, only 1 percent is easily accessible as ground or surface water, the remains are stored in glaciers and icecaps. Moreover, freshwater is not evenly distributed across land surfaces, and there are a number of heavily populated countries located in arid lands where fresh water is scarce. In this study treated waste water is used in concrete as an alternative for fresh water which helps to reduce the load on nature. This study concluded that the use of treated waste water, domestic sewage waste water has no noticeable side effect on the strength of concrete produced from them. The replacement of potable water by treated waste water conserved the natural water resources and increased the strength of concrete.*

Keywords: Treated Waste Water, Environment, Fresh Water, Construction Industry

Introduction

Concrete being most widely used construction material in construction industry. As per provision of IS 10262-2009, 186 liters water is required for 1m3 of concrete. On an average 150 liters water is required for 1m3 of concrete. The construction of 10,000 sq.mt. multi-storied structure can require about 10 million liters water for production, curing and site development activity. Also, in construction industry water is used for mixing, aggregate washing, curing of concrete and for washing concrete related mechanical machines. Water which is used for drinking purpose is suitable for water used in concrete. About 97 percent of water is held in the oceans, while only 3 percent is fresh water. Of the freshwater, only 1 percent is easily accessible as ground or surface water, the remains are stored in glaciers and icecaps. Moreover, freshwater is not evenly distributed across land surfaces, and there are a number of heavily populated countries located in arid lands where fresh water is scarce. Therefore, it is necessary to find out alternative for water used in concrete. In this study waste water from various sources like industrial process, domestic uses are treated and used in a concrete which help to reduce scarcity of water from nature.

Literature Review

K. Nirmalkumar and V. Sivkumar (2008) Studied on the durability impact of concrete by using recycled waste water. They used the recycled waste water from the tannery industry for the construction purpose, so that the shortage in water can be greatly reduced by making some primary treatment. Then the specimens were also casted by adding the concave admixture with dosages of 0.5%, 1.0%, 1.5%, 2.0% and 2.5%. The specimens were tested for durability properties for 28 days, 90 days and 365 days. Their study reveals that concrete using untreated tannery effluent and treated tannery effluents that can be used for construction purpose by giving a minimal treatment to sulphate attack.

R. A. Taha (2010) *et al* investigated the feasibility of using Ground (brackish) water and Production (oily) water in construction Compared with Tap water. Non-fresh water samples were obtained from four PDO (Petroleum Development Oman) asset areas. Nine water samples, including controlled potable (tap) water, were analyzed for pH, total dissolved solids (TDS), chloride, hardness, alkalinity, and sulphates. In addition, cement pastes and mortars and plain concrete mixtures were prepared using 100% substitution of potable water. Nine mixtures were prepared and cured for up to one and a half years. Mixtures were tested for initial setting times, compressive strength and flexural strength. Research results indicate that there was a small decrease in the initial setting times for all cement paste mixtures prepared using production and brackish water in comparison with potable water.

M. Silva and T. R. Naik (2010) Studied on sustainable use of resources, such as use of reclaimed water, especially partially processed sewage treatment plant water in concrete. An initial laboratory investigation was conducted samples were collected from the Milwaukee Metropolitan Sewerage District (MMSD) and analyzed the Characteristics of reclaimed wastewater. According to their investigation the compressive strength, mortar cubes with sewage treatment plant water has shown improvement in strength during 3 to 28 days and increased by the duration of 91 days.

K. S. al jabri*et al* (2011) (4) Investigated the effect of waste water on properties of high strength concrete. In that wastewater samples were collected from three car

washing station in Muscat area. The collected wastewater samples were mixed together and chemical analysis was carried out. Four water samples, including controlled potable (tap) water were analyzed for pH, total dissolved solids (TDS), chloride, hardness, alkalinity, and sulfates. Their chemical analysis results showed that although the chemical compositions of wastewater were much higher than those parameters found in tap water, the water composition was within the ASTM standard limits for all substance indicating that the wastewater produced can be used satisfactorily in concrete mixtures..

V. P. Kulkarni *et al* (2014) Studied on compressive strength of concrete by using treated domestic waste water as mixing and curing of concrete.By using oftreated domestic waste water utilized in concrete preparation where there was a scarcity of fresh water. They discussed physical properties of Materials and chemical properties of treated domestic waste water of mix proportion for M20 and M40 grade concrete the number of specimens to be cast for different curing regimes and elaborate average compressive strength results of M20 grade concrete cast by using Tap water as mixing and curing water for Mix M1 & treated domestic waste water as mixing and curing water for Mix M2 Similarly average compressive strength results of M40 grade concrete cast by using Tap water as mixing and curing water for Mix M3 & treated domestic waste water as mixing and curing water for Mix M4. Their results cover, M20 grade concrete at the age of 7 days the average compressive strength for all the 2 mixes was nearly same. At the age of 14 days marginal increase in compressive strength was observed in case of mix M1 but in case of mix M2 compressive strength remains same as that of 7 days and at 28 days curing age decrease in compressive strength was observed. This decrease in compressive strength may be due the use of treated domestic waste water for mixing and curing.

R.A. More, S.K. Dubey (2014) Studied on effect of different types of water on compressive strength of concrete. They made concrete cube with mineral water, tap water, well water and waste water increased with days & not having much variation in their compressive strength. The concrete mix of M20 grade with water cement ratio of 0.5 was investigated. Water samples were collected from various sources at college campus and were used to cast 150mm concrete cubes. The cured cubes were crushed on 7 & 28 days for compressive strength estimation. Also concluded that concrete made with different qualities of water samples such as ground water, packed drinking water, waste water etc. have 7 and 28-day compressive strength equal to or at least 90% of the strength of reference specimens made with clean water for M20 grade of concrete (Except waste water specimen for 7-day).

E.W. Gadzama *et al* (2015) Studied on the effect of using sugar factory waste water as a mixing water on the properties of normal strength concrete. In that the setting time of wastewater increases with an increase with percentage replacement, sugar wastewater from the factory was found to be acidic and the strength increases with an increase in curing duration. However, there were appearances of hair-like cracks all over the cubes casted with an appreciable volume change in the dimension of the cubes. Tests were carried out include, setting time of cement mixed with wastewater, composition analysis of wastewater as compared with portable water and compressive strength of concrete. Due to this there was substantial delay in the setting time of the cement mix using wastewater, the delay increases with an increase in the percentage of mixing wastewater. Concentrations of metallic elements as measured from the wastewater and compared with that of portable water revealed that Zinc, Lead and Sodium were within the range of WHO standard and the wastewater had a pH that was acidic, outside the quoted standard. Positive volume changes as much as 3.03% was observed and measured using a digital meter. Target strength at 28 days was not met, but it ranged from 83% - 91%, however, when the curing duration was extended to 90 days, the concrete cubes produced strength that Surpassed the target strength.

Research Gap

The literature search indicated that various sources of non-fresh water including sea and alkali waters, mine and mineral waters, waters containing sewage and industrial wastes, wastewater produced from ready-mixed concrete plants, and solutions of common salt were previously tested for use in concrete mixtures. It is difficult to draw a common conclusion regarding the use of these waters in concrete mixtures since impurities that exist in each water type are different. However, the general agreement is that there is a reduction in the ultimate strength of concrete when impure water is used. But with proper mix design (such as use of more cement and use of cementitious materials and admixtures) and by using some acceptable tolerance limits, it is possible to use impure water in concrete mixing and curing.

Methodology

List of steps used to carry out the investigation are as follows:

1) To collect material this is used in conventional concrete.
2) Testing of collected material.
3) To prepare mix design of concrete for M30 grade.

4) To collect treated waste water from Waste water treatment plant (PTWW & STWW) & Domestic waste water from simply city.
5) To determine the chemical characteristic of the wastewater (pH, TSS, Hardness, BOD, COD).
6) To prepare the concrete specimen by using Fresh water, PTWW, STWW & Domestic waste water.
7) To test casted specimen to obtain compressive strength, tensile strength & flexural strength.
8) To compare obtained results of treated waste water of each specimen with result of fresh water concrete

Chemical properties of waste water, test on cement, and test on aggregate were conducted & mix design for M30 grade concrete was prepared to cast specimen for conducting a test.

Result & Discussion

1. Alkalinity of water

- The pH of PTWW, STWW, Domestic water and Portable water is above 6
- The TSS of PTWW, Domestic water was more but for STWW was less than 100mg/l which is within given limits as per BIS.
- BOD and COD of PTWW, STWW, and Domestic water are within the desirable limit

2. Consistency of cement paste

- As the quality of mixing water deteriorates it affects consistency of cement.
- The consistency of cement paste using STWW increases by 1.69% as compared to potable water.
- The consistency of cement paste using PTWW and Domestic water is more than STWW.
- As per IS guidelines consistency of cement is 24–30 % of cement. So, the results obtained are within permissible limits.
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3. Initial and Final setting time of cement

- The initial setting time of cement paste is increased by 5.88% for STWW as compared to potable water.
- The initial setting time of cement paste for PTWW and Domestic water is more than STWW.
- As per recommendation of IS standards the initial setting time should not be less than ±30 min and final setting time should be less than 600 min given in IS 456 : 2000.
- The initial and final setting time of cement paste is as per guidelines recommended by IS456:2000 Quantity of cement sample taken for test (W1) gm.-400 gm.

4. Compressive strength of mortar cubes

- Compressive strength of mortar cube by mixing STWW for 7 days is near about same as Potable water.
- Compressive strength of mortar cube prepared with STWW shows improvement in the strength by 7.7% as compared to Potable water for 28 days.
- The mortar cubes prepared with PTWW and Domestic water shows decreasing results as compared with potable water.

5. Workability of concrete

- For PTWW, STWW, Potable water and Domestic water the slump value varied between 90 – 100 mm. Slump of concrete is not affected by adding PTWW, STWW, Domestic water compared to Potable water.
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6. Compressive strength of concrete

- The compressive strength of concrete is increased by 2 % for STWW at end of 60 days as compared to Potable water.
- The strength gained is slower but at the end of 60days it is more than potable water.
- PTWW contains more algae content and thus reduce the strength of concrete.

7. Split tensile strength

- The spilt tensile strength of concrete by mixing PTWW, STWW and Domestic water was not affected.
- The strength of STWW was slightly increased compared to Portable water.
- The strength of PTWW and Domestic waste water is also normally increased

8. Flexural strength

- The PTWW was giving the less strength as compared with portable water as 4.0 N/mm2.
- The flexural strength of concrete is increased by 4.4 % by mixing STWW as compared to potable water given as 5.56 N/mm2.
- The Domestic waste water giving the better results as compared to PTWW.

Conclusion

This study concluded that the use of treated waste water, domestic sewage waste water has no noticeable side effect on the strength of concrete produced from them. The replacement of potable water by treated waste water conserved the natural water resources and increased the strength of concrete.

1. In this work M30grade of concrete used. The potable water is fully replaced with the PTWW, STWW, and Domestic Waste Water. The test conducted on all types of waste water are pH, Total suspended solid (TSS), Hardness, Biological oxygen demand (BOD), Chemical oxygen demand (COD). The results shows that pH of all type of waste water is above 6 as per BIS guidelines. The TSS of PTWW and domestic waste water was more than STWW. it was less than 100 mg/l which is in the given limits. As per BIS limits BOD &COD of PTWW and domestic waste water are within the desirable limit as per BIS, Government of India.
2. The tests taken on cement are standard consistency of cement, initial and final setting time and compressive strength of cement mortar. The results show that the standard consistency of cement paste using STWW increases by 1.69% as compared to potable water. The standard consistency of cement of PTWW & domestic waste water is 5.88% more than STWW. The compressive strength of cement mortar cube by mixing STWW for 7 days is near about same as potable water and after 28 days STWW shows improvement strength about 7.7% as compared to potable water.
3. The tests taken on concrete are the compressive strength of concrete, splitting tensile strength and flexural strength replaced by PTWW, STWW and domestic waste water by potable water. The results shows that compressive strength of concrete is increased by 2% for STWW up to 60 days as compared potable water.
4. The split tensile strength of concrete results PTWW, STWW and domestic waste water remain same.

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